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Research Brief

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Using Soil Amendments to Reduce Edge-of-Field P Losses

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Use of soil amendments can be a best management practice (BMP) to reduce edge-of-field P losses, which supply P to impair water quality. Numerous amendment studies have been conducted throughout Florida over the years by several investigators, utilizing a wide variety of amendments. Interpreting the results of these studies is complicated by the wide variety of amendments, amendment rates, soils, P sources, and P loss mechanism(s) investigated. The purpose of our work was to conduct a systematic evaluation of numerous soil amendments using standardized protocols to provide directly comparable results upon which to judge amendment effectiveness. Amendments were applied to a composite soil, representing multiple samples of surface soil from an expected field demonstration site in the Lake Okeechobee (LO) watershed.

Choosing amendments and rates

Ten materials were selected for evaluation as amendments at various rates of application. All materials are produced or marketed in Florida, and most have been evaluated to some degree by Florida researchers as amendments for P-impacted soils or waters. Amendment rates were initially chosen to represent wide ranges that encompassed rates reportedly effective at controlling P solubility/mobility.

Standardized Protocols

Amendment analyses

Amendments were treated with strong acid to yield a digest suitable for total elemental analysis. Analysis results were compared with guidelines for amendment effectiveness and potential soil/plant/animal impacts.

Lab equilibration study

A lab equilibration (incubation) study was conducted of composite LO watershed soil with amendments. The amount of soluble P remaining in the equilibrated suspension was compared to that in the control suspension (no added amendment).

Small column leaching study

A small column study was designed to evaluate amendment effectiveness at reducing P leaching in a controlled laboratory setting. Amended soil was treated with tap water (pH 5), equivalent to 5-cm irrigations, weekly for a total of 8 weeks.

Simulated rainfall study

The final protocol was a simulated rainfall study using equipment and procedures specified by the National P Project protocol to measure runoff. The design was modified slightly in our experiments to quantify leaching of P in addition to runoff P by adding a second box under the first in a double-decker design. This design allowed collection of runoff and leachate simultaneously. Runoff and leachate samples were analyzed for soluble reactive P, biologically available P, and total dissolved P.

Runoff (large jugs) and leachate (smaller bottles) collection during rainfall simulation. Amendments visible on soil surfaces.

Selection Summary

Results of the evaluation protocols identified amendments worthy of field investigation. A summary of the pertinent criteria used to select or deselect amendments follows:

DuPont Fe-"humate" - deselected because of minimal P sorption capacity.

Coal slag - despite good adsorption and leaching control properties, the material is deselected because of troublesome trace element contents, especially Mo and As and because the rates of coal slag required for P control could detrimentally affect soil pH and salinity.

Pro-sil - despite effective P sorption, effective leaching control, and moderate runoff control, the material is deselected because the rates required for P control can raise soil pH excessively which, when combined with the amendment's moderately high Mo content, could create an undesirable soil environment for pasture grass growth and grass quality that may threaten livestock health (molybdenosis).

Gypsum - very effective at controlling P leaching, but ineffective at P sorption and P runoff control. Also deselected because rates necessary for P control may result in soil salinities incompatible with sustained good pasture grass growth.

Lime and Ca-WTR – behaved essentially the same in all protocols. Lime is likely effective in initially acid soils requiring pH adjustment, but not in soils with pH values ≥7, where its solubility is limited. P-impacted Lake Okeechobee soils have pH values near 7 so little liming agent would be recommended, and such low amendment rates are largely ineffective. Both liming agents were, thus, deselected.

Vigiron (Fe-WTR) - moderately effective at sorbing P and reducing leaching, but only fair in controlling P runoff. Deselected because it contains moderately high concentrations of Mo and As, and may release P under reducing conditions.

dinoSoil - high rate (1%, 10 T/A) slightly effective at sorbing P and reducing leaching, but a top performer in runoff simulations because soil surfaces become sealed. High cost (~$145/T) likely makes the amendment impractical for large scale use.

Manatee and Okeechobee Al-WTRs – both are effective P sorbers, but are ineffective at controlling P leaching when soluble P is below the zone of amendment incorporation. Soluble P must be made to contact WTRs (amendment incorporation, or soluble P added after amendment addition). The Al-WTRs dominated the best materials in runoff simulations. The Manatee material is recommended for field testing because of abundance and ease of handling, and should be tested as both surface-applied and soil incorporated at the 2.5% (25 T/A) rate.

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